Micro-Pattern Gaseous Detectors (MPGDs)

Instrumentation Frontier Topical Group 5 (IF5)

Co-conveners:

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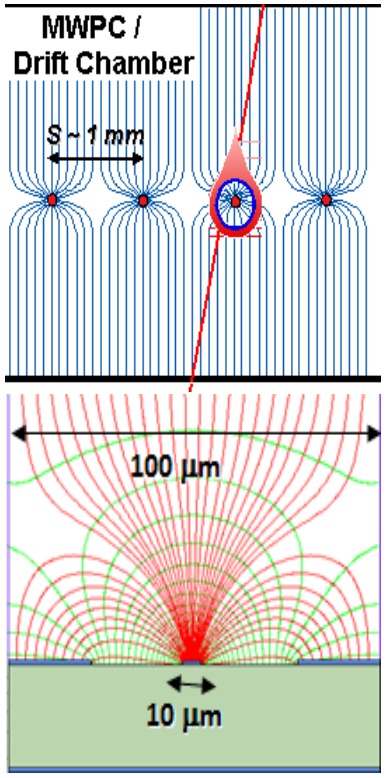
SNOWMASS-IF-05-MPGD-CONVENERS@fnal.gov

Overview

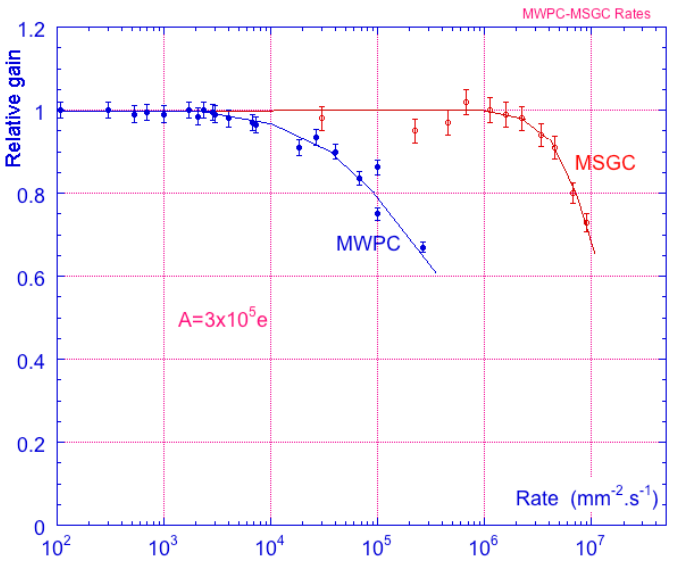
- Introduction to MPGDs
- The role of RD51
- Goal of our topical group
- Process
- Plans
- Communication / how to get involved

Introduction

- Micro-Pattern Gaseous Detectors (MPGDs) are gas-avalanche-based devices enabled by modern photolithography
- Higher rate capabilities and finer segmentation
- First: Micro strip gas chamber (MSGC), 1988
- Of interest for particle/hadron/heavy-ion/nuclear physics, neutrino physics, and dark matter detection, including operation at cryogenic temperatures.
- Charged particle tracking, photon detection and calorimetry, neutron detection and beam diagnostics
- Beyond fundamental research, in use and considered for scientific, social, and industrial purposes; this includes the fields of material sciences, medical imaging, hadron therapy systems, and homeland security.

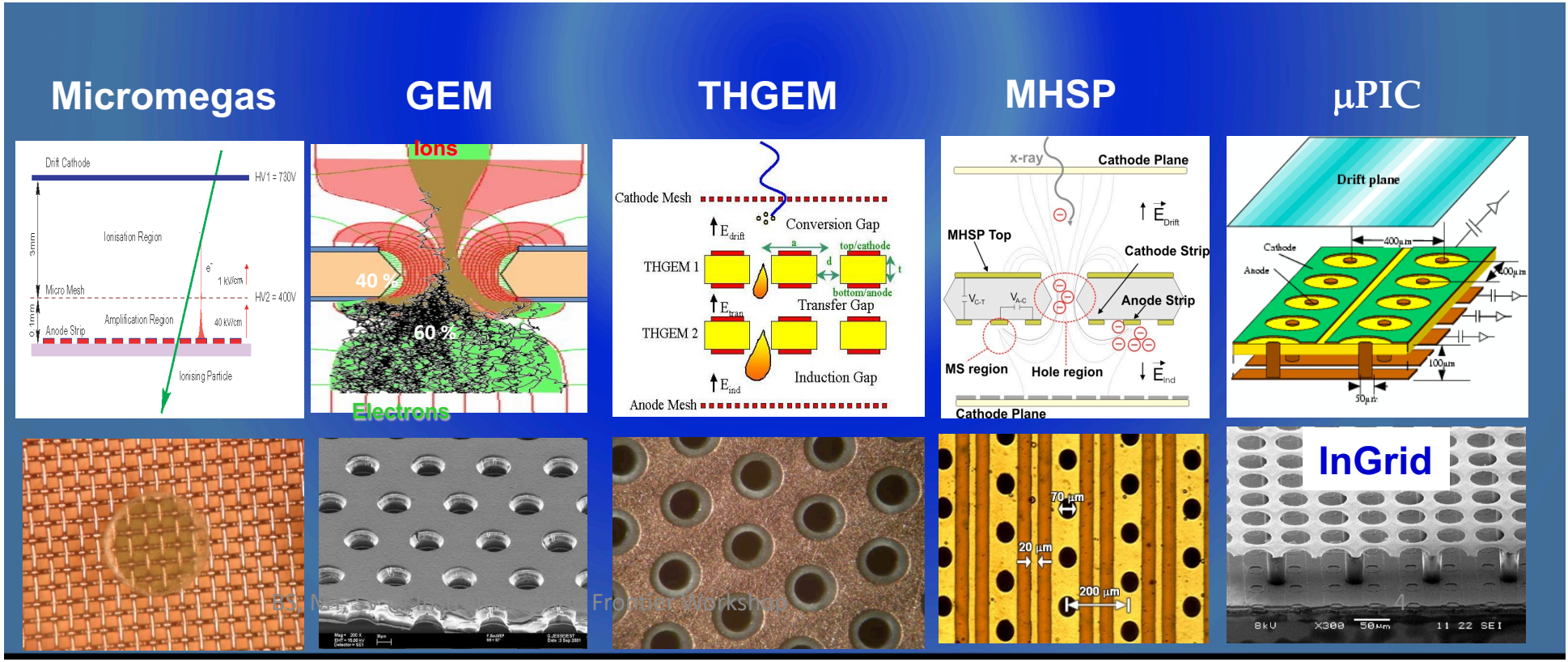


Rate Capability:
multi-wire proportional counter (MWPC)
vs MSGC



Current MPGD technologies

- Include the Micro-Mesh Gaseous Structure (MicroMegas), Gas Electron Multiplier (GEM), THick GEMs (THGEMs), also referred to in the literature as Large Electron Multipliers (LEMs), the Resistive Plate WELL (RPWELL), the GEM-derived architecture (micro-RWELL), the Micro-Pixel Gas Chamber (µPIC), and the integrated pixel readout (InGrid).
- In recent years, there has been a surge in the use of MPGDs.
- Now used in major ongoing particle-collider experiments (e.g., ATLAS, CMS, and ALICE at the LHCb) and in development for future facilities (e.g., EIC, ILC, FCC, and FAIR).



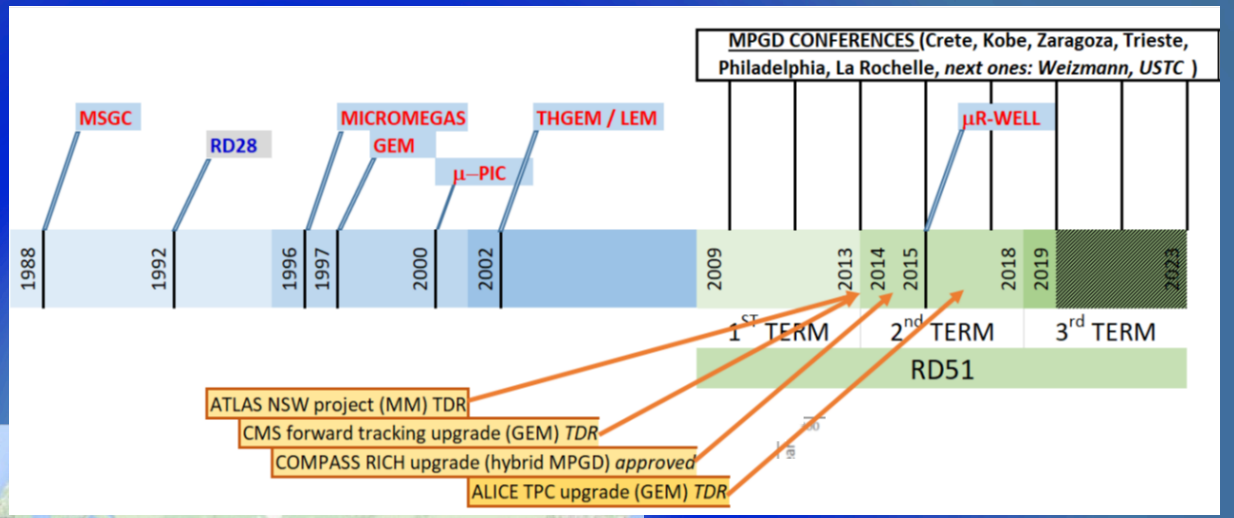
History of MPGDs and RD51 Collaboration

The main objective is to advance MPGD technological development and associated readout systems, for applications in basic and applied research": http://rd51-public.web.cern.ch/rd51-public

A majority of MPGD developers and users coordinate and collaborate as part of the CERN-RD51 collaboration.

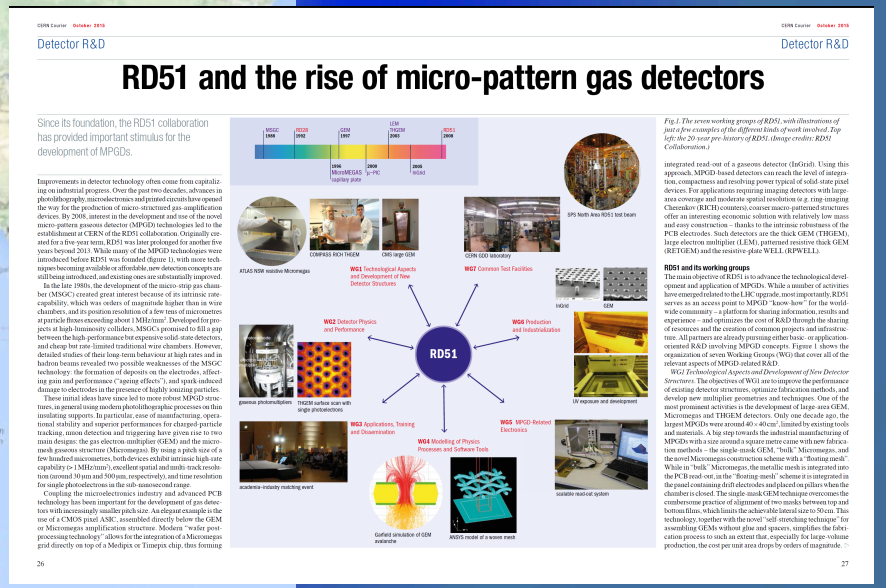
RD51: Advance MPGD expertise & community-integration in all regions

→ there is a growing MPGD community in the USA



- Large Scale R&D program to advance MPGD Technologies
- Access to the MPGD "know- how"
- Foster Industrial Production

- ~ 90 institutions
- ~ 500 members
- National and International Laboratories
- National Institutes and Universities



Detector R&D

RD51 and the rise of micro-pattern gas detectors

(CERN Courier, Oct. 2015)

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RD51 (well-consolidated) WGs & Cultural Network

WG1: Technologies & New structures ⇨ R&D support for experiments and LHC upgrades

WG2: Characterization & Detector physics

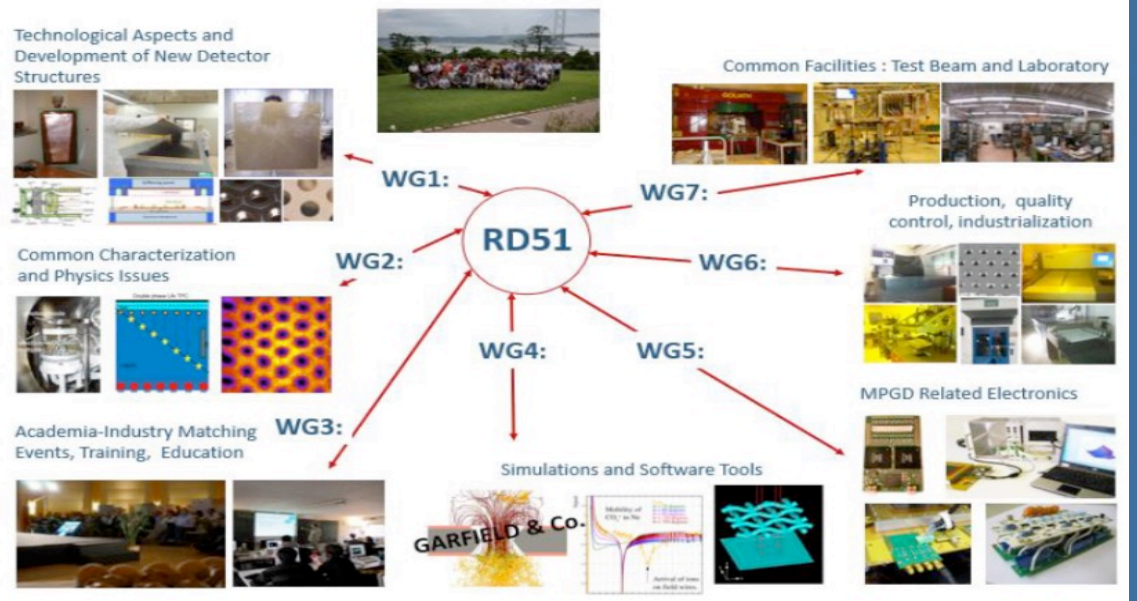
WG3: Training and dissemination

WG4: Software & Simulation Tools

WG5: Readout Electronics (RD51 SRS)

WG6: MPGD Production & Industrialization

WG7: RD51 Lab and Test-Beam Infrastructure



Expertise & people

CERN GDD team

RD51 groups

Tools & facilities

GDD Lab

MPT Workshop

Thin Film Lab

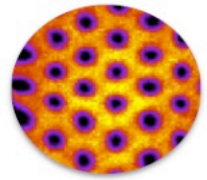
Test Beams

Simulation Tools

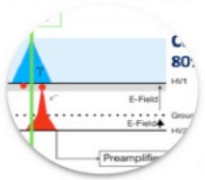
Electronics

Activities

Detector physics

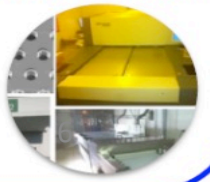


Generic R&D



Meetings & conferences

Industrialization

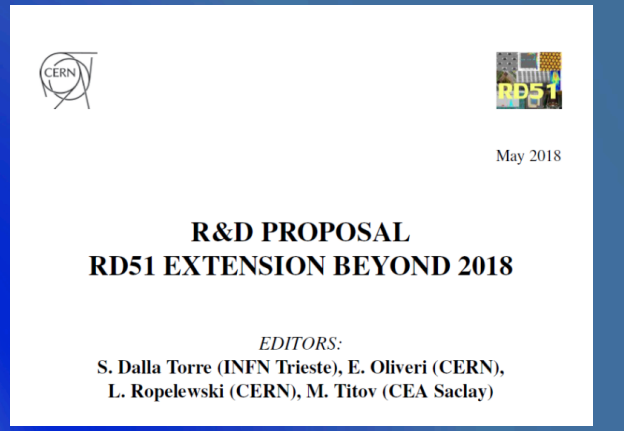


Substantial documentation already exists

RD51: Recent Documents

June 2018:

- ✓ R&D PROPOSAL: RD51 Extension beyond 2018"– Approved by the CERN Research Board until 2023 https://arxiv.org/abs/1806.09955


May 2018

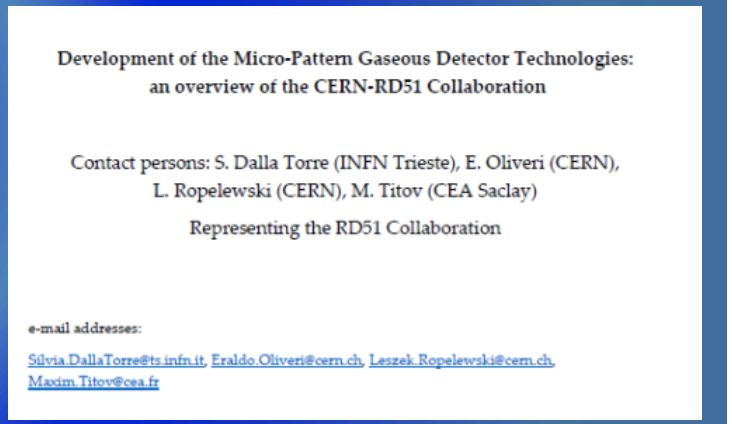
R&D PROPOSAL
RD51 EXTENSION BEYOND 2018

EDITORS:
S. Dalla Torre (INFN Trieste), E. Oliveri (CERN),
L. Ropelewski (CERN), M. Titov (CEA Saclay)

December 2018:

- ✓ Input for the EPPSUprocess: "Development of the MPGD Technologies: an overview of the CERN-RD51 Collaboration"

https://indico.cern.ch/event/765096/contributions/3295721/


Development of the Micro-Pattern Gaseous Detector Technologies: an overview of the CERN-RD51 Collaboration

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Representing the RD51 Collaboration

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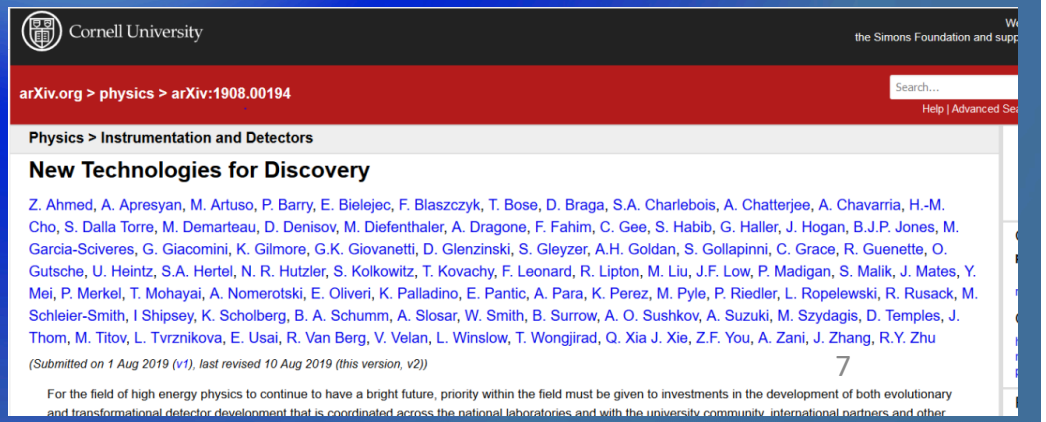
Summer 2019:

- ✓ Document for the CPAD report "New Technologies For Discovery"

Progress of MPGDs and RD51 model https://arxiv.org/abs/1908.00194


Cornell University

arXiv.org > physics > arXiv:1908.00194

Physics > Instrumentation and Detectors

New Technologies for Discovery

Z. Ahmed, A. Apresyan, M. Artuso, P. Barry, E. Bielejec, F. Blaszczyk, T. Bose, D. Braga, S.A. Charlebois, A. Chatterjee, A. Chavarria, H.-M. Cho, S. Dalla Torre, M. Demarteau, D. Denisov, M. Diefenthaler, A. Dragone, F. Fahim, C. Gee, S. Habib, G. Haller, J. Hogan, B.J.P. Jones, M. Garcia-Sciveres, G. Giacomini, K. Gilmore, G.K. Giovanetti, D. Glenzinski, S. Gleyzer, A.H. Goldan, S. Gollapinni, C. Grace, R. Guenette, O. Gutsche, U. Heintz, S.A. Hertel, N. R. Hutzler, S. Kolkowitz, T. Kovachy, F. Leonard, R. Lipton, M. Liu, J.F. Low, P. Madigan, S. Malik, J. Mates, Y. Mei, P. Merkel, T. Mohayai, A. Nomerotski, E. Oliveri, K. Palladino, E. Pantic, A. Para, K. Perez, M. Pyle, P. Riedler, L. Ropelewski, R. Rusack, M. Schleier-Smith, I Shipsey, K. Scholberg, B. A. Schumm, A. Slosar, W. Smith, B. Surrow, A. O. Sushkov, A. Suzuki, M. Szydagis, D. Temples, J. Thom, M. Titov, L. Tvrznikova, E. Usai, R. Van Berg, V. Velan, L. Winslow, T. Wongjirad, Q. Xia J. Xie, Z.F. You, A. Zani, J. Zhang, R.Y. Zhu

(Submitted on 1 Aug 2019 (v1), last revised 10 Aug 2019 (this version, v2))

For the field of high energy physics to continue to have a bright future, priority within the field must be given to investments in the development of both evolutionary

Goals of MPGD topical group

- This Snowmass 2021 topical group will document recent developments and identify future needs for Micro-Pattern Gaseous Detector (MPGD) technologies
- Questions about scope and topical boundaries:
  - Do we cover existing and required MPGD frontend and readout systems, such as the CERN SRS system? We think yes for MPGD specific solutions. But need to discuss with IF07: Electronics/ASICs and IF04: Trigger and DAQ
  - Do we encourage nuclear physics contributions? We think yes. Strong technology requirement overlap between NP and HEP.
  - Are MPGD trackers covered under MPGD or IF03: Solid State Detectors and Tracking? We think MPGD. Or both groups, and collaborate on report.
  - MPGD single photon detectors – covered by us or IF02: Photon Detectors? Need to discuss.

Process: so far

- Weekly convener meetings
- Have contacted known MPGD communities and enthusiasts internationally, encouraged subscription to our mailing list: SNOWMASS-IF-05-MPGD@FNAL.GOV
- Currently, 32 people subscribed

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Process: Next steps

- Any groups interested in MPGD detectors should
  - Contact the IF5 working group co-conveners: SNOWMASS-IF-05-MPGD-CONVENERS@fnal.gov
  - Sign up for our mailing list SNOWMASS-IF-05-MPGD@FNAL.GOV
  - Submit a 2-page Letter of Interest by August 31, 2020. Further details on submitting written contributions can be found at: https://snowmass21.org/loi.
- Collaborations we know are planning LOIs at this point
  - EIC (nuclear physics)
  - CYGNUS (directional WIMP and neutrino detection)
  - RD51
  - LCTPC [considering]
- Hope to get a fairly "complete" set of LOIs. Plan to to encourage contributions from all known experiments/efforts with US involvement that are not represented
- After LOI deadline, considering virtual MPGD Snowmass workshop to engage MPGD community, coordinate contributed papers, and plan process towards final report

Communication

- You can reach all three convernors at: SNOWMASS-IF-05-MPGD-CONVENERS@fnal.gov
- All future MPGD-specific announcements will be sent to our mailing list SNOWMASS-IF-05-MPGD@FNAL.GOV
- We have a MPGD wiki-page where we plan to post future meeting announcements and minutes: https://snowmass21.org/instrumentation/mpgd
- For more detailed discussions and input on the process, we will be using the collaboration tool Slack: team snowmass2021, channel #if05-mpgd Using a CERN or Fermilab e-mail address to join the team should work. If not, please e-mail rhbob@fnal.gov with the subject line "snowmass slack" for help.

Summary

- MPGD topical group getting reasonably well organized
- Challenge for this topic: past MPGD development centered in Europe
- Critical for growing US MPGD community to engage in Snowmass process to ensure needed future support.
- Particularly important given that MPGDs not included in BRN report

Submit your LOIs!